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EDITORIAL

Monash at the academic industrial interface: trains and platforms

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A faculty with 'a place in the world'

Founded in 1958, Monash University in Melbourne, Australia, has a reputation as an international, research-focused institution. Today, Monash encompasses 55,000 students, 14,000 staff, 10 faculties, and eight campuses (including campuses in Malaysia and South Africa).

The Faculty of Medicine, Nursing, and Health Sciences offers the most diverse range of programmes in health and medicine of any Australian university with over 1,700 staff, 1,500 adjunct staff, and around 6,500 students. It is ranked in the highest tier among Australian universities for teaching and learning.

Located at six campuses, the faculty comprises ten schools (each with multiple departments), 29 teaching and clinical centres, and two research institutes—the Monash Institute of Medical Research (MIMR) and the Australian Regenerative Medicine Institute (ARMI). ARMI is also the headquarters for Australia's associate membership of the European Molecular Biology Laboratory (Fig. 1).

'From bench to bedside'

The faculty's strong research reputation is based on key research themes including regenerative medicine, stem cell science, cardiovascular disease, cancer, structural biology and drug development, global infection and immunity, inflammation, allergy and auto-immunity, and mental health and cognitive neurosciences.

The faculty places a strong emphasis on translating research and with sites at major hospitals and clinical centres throughout Melbourne and rural Victoria. Monash researchers are ideally positioned to transfer their work from laboratory to clinic and out into the community.

Partnering for success

Sustained access to top research and development (R & D) infrastructure is a burden shared by academia and industry. Staff scientific skills need refreshing and updating on a frequent basis, and due to technological advances, equipment is often expensive and of limited lifespan. The cost burden on small laboratories and small-to-medium-sized enterprises (SMEs) means that key experimentation and validation steps are often performed on old instrumentation by poorly trained staff. Hiring and training staff plus purchasing and acquiring new equipment affects timeframes. Alternatively, these key experiments are not done at all. Well-financed organisations provide more infrastructures, but cannot provide for all eventualities, and even so, expensive equipment and technologies, as well as trained staff need to be deployed more efficiently to maximise capital.

Organising around and investment in platform technologies provide a cost-effective solution, and Monash has taken the approach of concentrating technology in key platform areas in order to support its own researchers and as part of a plan to engage academic collaborators and industry.

In Australian academia, most research is performed in small groups with access to a limited range of equipment

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Fig. 1 Monash University, Clayton campus

and skills to suit immediate needs with little capacity to expand into broader areas of related research or to undertake even moderate scale translational research. Similarly, small-to-medium biotechnology companies require access to often sophisticated R & D technology and expertise without having to hire skilled personnel and avoiding extensive purchasing and renewal of high technology infrastructure. Both academic and industrial groups benefit from access to shared cutting edge infrastructure run by skilled operators, and which has appropriate access arrangements, high quality governance, and transparent cost structures.

Interactions between academia and SMEs are often characterised by proof of principle data on the academic side that is too limited to meet the proof of concept needs of the industry partner. This challenges the willingness of industry to fund academic science. To accelerate a project to the proof of concept stage, industry can provide the infrastructure to build prototypes of the discovery—but this often comes at the price of lack of involvement in the ongoing research by the academics, with a concurrent lack of intellectual engagement and a lower perceived value of the project to both sides. Alternatively, academia can provide industrial quality infrastructure to build prototypes and so, remain more engaged in the R & D process. This approach using high quality technology platforms benefits industry through greater intellectual input and improves value from all points of view.

Partnering with the Government of the State of Victoria, Monash chose the latter path to add value to its academic and industrial projects. For example, new drug targets can be exploited through structure-based design and medicinal chemistry development. New biotherapies, such as monoclonal antibodies and vaccines, can be identified, designed and manufactured at scales suitable for pre-clinical efficacy, toxicology testing, and early-scale clinical trials.

In 2001, the Victorian Government launched the Biotechnology Strategic Development Plan (BSDP)—a three-year action plan capitalising on the state's strengths in biomedical research. The initial focus of the BSDP was on strengthening Victoria's R & D sector through significant investment in infrastructure and capacity building. The current version of the plan places emphasis on mechanisms that ensure the capture and translation of discoveries into practise and products, including measures that focus and build on human and financial capital.

The Monash cluster is the University's response to the State government initiative and forms part to its roadmap for industry engagement. This cluster is a multi-disciplinary consortium of centres, schools, institutes, and hospitals, holding a shared vision to contribute to Victoria's success as a research and biotechnology centre (Fig. 2).

Monash's technology platforms are part of the cluster's infrastructure. The desire to develop an inter-operable suite of technology platforms arises from a belief that complex problems can be better solved through a multi-disciplinary, technology-systems approach.

Technology platforms are defined as core facilities or capabilities that provide high quality specialist services to the research community, government, and industry. Such facilities might include genomics (i.e., DNA sequencing and synthesis), imaging, antibody production, proteomics, compound library screening, pre-clinical ADME-Tox, and animal provision. Platforms often evolve from local or

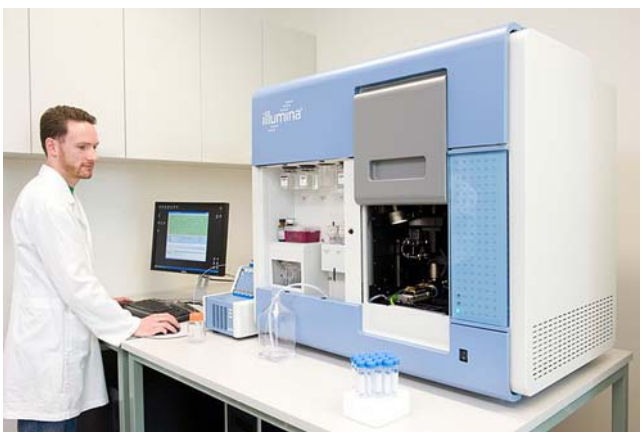

Fig. 2 Monash University, genomics facility

Table 1 Partial catalogue of technology platforms Monash University. Operational platforms are shaded green, while those under development are shaded orange

Platform	Description
Centre for Drug Candidate Optimisation	Lead candidate optimisation in support of emerging drug discovery programmes
Centre for Green Chemistry	Cleaner synthesis technology, green biotechnology
FlowCore	Flow cytometry
Micromon (genomics)	DNA sequencing and synthesis
Monash Antibodies Technology Facility	Production of monoclonal antibodies
Monash Animal Research Platform	Provision of animals for research and teaching
Monash Centre for Electron Microscopy	Detailed imaging of small particles
Monash Institute in pharmaceutical sciences	Drug candidates for preclinical and clinical development
Monash microimaging	Optical imaging and EM
Protein production unit	Cloning, expression and purification of proteins
Proteomics	Basic protein characterisation
Victorian Bioinformatics Consortium	Bioinformatics research and support
FishCore	Zebrafish models for disease
Bioimaging	Biomedical imaging (e.g., PET and MRI)
Structural biology	Protein crystallisation and determination of structure

shared infrastructure and develop into consolidated, well-managed technology capabilities delivering high-quality service in a timely fashion. Core facilities operating at the level of a 'true' platform are characterised by:

- State-of-the-art equipment;
- Internationally and/or nationally respected operators;
- Standardised and accredited standard operating protocols;
- A reputation for providing the timely delivery of a quality product or service;
- Highly trained staff, dedicated to the facility, who can troubleshoot;
- Coordinating and resourcing of the instrument maintenance/service by formal agreements;
- Advertisement of the capability across the organisation; and
- Business planning.

Monash currently has 12 recognised technology platforms/capabilities with three under active development and another under consideration (Table 1). Other shared infrastructure within Monash and across Victoria will be identified and characterised from a comprehensive mapping exercise funded by the Victorian government. The university has also developed strong relationships with its affiliated medical research institutes and hospitals, as well as with the Commonwealth Scientific and Industrial Research Organisation and with the Australian Synchrotron.

Monash is now undertaking a more coordinated approach to the management of its platforms, aiming to increase scale and to seamlessly consolidate them, enabling research platform that will operate at world's best practise. Integration of these core facilities, with appropriate support, allows Monash to better engage with its own constituency, as well as with industry and government, ultimately providing a first class 'one stop technology shop'.

Operating an integrated suite of technology platforms promises a number of benefits, including:

- Greater coordination of shared infrastructure, with a common management and governance structure enabling better integration of services (technology pipeline);
- Improved access to publicly funded, shared infrastructure through centralisation and consolidation of services, and building awareness through a common marketing strategy;
- A universal quality plan that mandates key performance indicators, annual reporting, and periodic review;
- Efficiency gains through the opportunity for centralised administrative support;

Fig. 3 Monash University, protein production facilities

- Attracting larger value, longer term research grants, and industry funding through the collaboration of key researchers and research groups;
- Improved capacity to attract more government funding to maintain and expand these platforms; and
- Provision of training opportunities for under-graduate and graduate students at the academic/industrial interface (Fig. 3).

The university provides the platforms with support services, such as human resources, finance, business development, and information technology departments in order to help integrate each of the platforms. HR ensures that the staff working through the platforms are appropriately rewarded. Finance assists with budgeting, project management, accounting, and contract management. Business development facilitates industry engagement, commercialisation, IP protection, business planning, marketing, and contract development. And information technology enables cross-platform linkages, process flow, project management, and sales and marketing.

A considerable benefit of technology platforms comes from harnessing their combined capabilities. Hence, through coordinated management and integration of core capabilities, Monash offers access to a technology 'pipeline' or 'mega-platform'. Participating platforms provide Monash researchers, academic collaborators, affiliated institutions, and the pharmaceutical and biotechnology industries access to a one stop technology shop.

A proposal for the development of a therapeutic monoclonal antibody can be taken from high throughput antigen design, production, purification, and characterisation through to immunisation of mice, selection of hybridomas at high throughput, screening for bioactivity, conversion to humanised formats, scale up, purification and characterisation, evaluation in animal models of disease, ADME and toxicology studies in large animal models, and preparation for clinical trials. Similarly, research and development of small molecule drug candidates or candidate vaccines can be pursued through a complementary and partially overlapping suite of platforms.

Independently of the concept being tested, candidate therapeutic and technology 'trains' based on small molecule drug targets, therapeutic antibodies and vaccines, and other, as yet, undefined projects can be developed by stopping at appropriate platforms with project management keeping them on the rails. This model of early R & D is entirely conventional in industry. When coupled with the imaginative environment of the modern day university, it will produce exciting new medicines and therapies by better connecting academia to industry.

As detailed in later chapters, the Monash platform technologies underpin a significant component of the universities research outputs. For example, the work of Professor Rossjohn and his colleagues is critically dependent on access to high throughput crystallisation technologies, as well as easy access to a high quality synchrotron technology. Using these technologies, Professor Rossjohn and his team have provided new and unique insights into the impact post-translational modifications on T cell epitopes have on immune recognition and potential immunotherapies [1]. Access to unique transgenic mouse models, bioinformatics, and coupled with high end genomic technologies have allowed Professor Bryan Williams and colleagues at the MIMR to examine how specific transcription factors play a critical role in immunity and cancer [2]. In the Monash and Immunology Stem Cell Laboratories (MISCL), Professor Richard Boyd and his group have utilised a number of the Monash platform technologies, including monoclonal antibody production and flow cytometry in their work examining the nexus between stem cells and the immune system [3].

The end game of this research is to bring the promise of stem cell therapies even closer to the clinic. Finally, in studies to examine the sources and targets of oxidative stress, Professor Harald Schmidt and colleagues will use specific antibodies developed in the Monash Antibodies Technology Facility to characterise NADPH oxidases (NOX), which are a critical component in the production of damaging reactive oxygen species in the vasculature [4].

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